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THE CASTOR BEAN PLANT AND LABORATORY AIR

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 178

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It is well known that the leaves of the castor bean (*Ricinus communis*) are likely to show nastic drooping after the plant has been brought into the laboratory. On account of the apparent definiteness of this response, it seemed probable that the plant would prove useful as a delicate test for certain gaseous impurities in laboratory air. It was with regard to this possibility that the studies reported below were undertaken.

Potted seedlings, grown under ordinary greenhouse conditions until they had developed 5–7 leaves, including the cotyledons, were used in the tests. The pots and soil were covered with paraffin to avoid absorption of the gases. Exposure periods were all approximately 60 hours. The methods of exposure to known concentrations of ethylene and illuminating gas were the same as described by KNIGHT and CROCKER[1] for these gases in their work on sweet pea seedlings. In the main, the 50–100-liter galvanized iron cans were used for exposure chambers, but, since here the plant would be in total darkness during the course of the experiment, some were exposed under bell jars provided with water seals and left in strong diffused light, in order to find what effect light would have on the sensitiveness of the response. Corresponding results, however, were obtained by the two methods. Illuminating gas tests were run parallel with those of ethylene in a manner to yield evidence whether the reaction was induced by the ethylene constituent of the illuminating gas. Ethylene occurs in the Chicago illuminating gas in the concentration of about 4 per cent, so pure ethylene was diluted with air to 4 per cent, so that, volume for volume, the illuminating gas and the ethylene-air mixture held about the same amount of ethylene. This stock mixture allowed parallel experiments to be carried out readily.

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[1] KNIGHT, L. I., and CROCKER, W., Toxicity of smoke. BOT. GAZ. 55:337–371. 1913.

The reaction itself is very easily observed. The most obvious effect of the gas is the nastic drooping of the leaves as mentioned above. This drooping is brought about by curvatures, located either at the inner or at the outer end of the petiole or at both. If the gas be of certain concentration, the older leaves may develop abscission layers that often result in leaf fall. And again, if the gas be somewhat stronger, rapid proliferation may take place at these new leaf scars, forming small masses of tissue which usually exude sap. The most delicate response of the plant seems to be a nastic folding down of the laminae of the young leaves. However, the very young leaves that are still more or less enveloped by the bud scales seldom show any response.

Data regarding the appearance and degree of these responses were obtained by observation of the following points. Previous to the exposure, the leaves of the plant were numbered consecutively from cotyledons upward. Also the condition and direction of the plane of the leaves were noted. This consisted in an examination for abscission layers already started, the measuring of the angle made by each petiole with the stem, and the angle made by the plane of the leaf surface with the petiole. After exposure, examination was made for leaf fall, starting of abscission layers, the new angles made by the petioles with the stem and by the plane of the leaf surfaces with the petioles, and, finally, the condition of the laminae of the young leaves was noted. The amount of nastic drooping at each end of the petioles was recorded in degrees.

The results of the experiments proved that this plant has great capacity for response to low concentrations of ethylene, just as one was led to expect from its common behavior in the laboratory. The lowest concentration tried was one part ethylene to 10,000,000 of air (or 0.00001 per cent). With this amount the response was absolutely definite, as shown, for example, in one case by a nastic drooping of 15° at the inner end of the petiole for leaf no. 5; by drooping of 30° and 15° at the outer ends of the petioles for leaves nos. 5 and 6 respectively; and by a nastic folding down of laminae for leaves nos. 6 and 7. Parallel experiments with illuminating gas and ethylene, where the ethylene constituent of the former was about equal to the ethylene in the corresponding ethylene-air mixture, gave results similar in kind and degree. This fact indicates that the ethylene of the illuminating gas is responsible for the reaction. Especially does this seem true in the light of similar results obtained by KNIGHT and CROCKER on sweet pea seedlings. The definiteness of the reaction with one part ethylene to 10,000,000 of air leads one to believe the plant

TABLE I

PLANT *A* EXPOSED TO 1 PART ETHYLENE TO 1,000,000 AIR; PLANT *B* EXPOSED TO 25 PARTS ILLUMINATING GAS TO 1,000,000 AIR (I.E., APPROXIMATELY 1 PART ETHYLENE TO 1,000,000 AIR); PLANT *C* THE CONTROL

Number of leaf	Plant	No response	Proliferation at leaf scar	Leaf fall	Starting of abscission layer	Nastic drooping of petiole; inner	Nastic drooping of petiole; outer	Nastic folding down of lamina of leaf
1 (cotyl.)	A	×	....	....	....	....	....	....
	B	....	....	....	×	....	....	....
	C	×	....	....	....	....	....	....
2 (cotyl.)	A	....	....	×	....	....	....	....
	B	....	....	....	×	....	....	....
	C	....	....	....	×	....	....	....
3	A	×	....	....	....	....	....	....
	B	....	....	....	....	....	× 45°	....
	C	×	....	....	....	....	....	....
4	A	....	....	....	....	× 45°	× 45°	× (?)
	B	....	....	....	....	× 30°	× 60°	....
	C	×	....	....	....	....	....	....
5	A	....	....	....	....	....	× 45°	×
	B	....	....	....	....	× (?)	× 45°	×
	C	×	....	....	....	....	....	....
6	A	....	....	....	....	....	× 90°	××
	B	....	....	....	....	× (?)	× 90°	××
	C	×	....	....	....	....	....	....

×× = very strong response.

capable of responding to even considerably lower concentrations than any yet tried. The least delicate of the reactions, the proliferation and exudation at leaf scars, usually appears in concentrations of about one part ethylene to 50,000 of air; while leaf fall and especially the starting of abscission layers may appear in concentrations as low as one part ethylene to 500,000 of air, or even one part ethylene to 1,000,000 of air. The nastic drooping of the youngest well developed leaves and the folding down of the laminae of the young leaves are the responses one must depend on for extremely low concentrations.

The accompanying table (table I) will serve to show the method of recording the reactions, and also how close is the parallelism between the ethylene and the illuminating gas under the conditions of concentration named above.

In conclusion it may be stated that the castor bean plant has proved capable of giving an easily observed response to extremely small amounts of ethylene; and on account of this fact the plant seems particularly useful for the detection of harmful gaseous impurities[2] in the air of laboratories and greenhouses.

The writer gratefully acknowledges the many valuable suggestions of Dr. WILLIAM CROCKER.

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[2] It would not be of value for such gaseous impurities as are not active in inducing this response, but ethylene, though in small amounts, is probably the most harmful and generally present of any laboratory air impurity.